Logo

Description automatically generatedRequirement analysis and specification document

*Davide Li Calsi 10613807*

*Andrea Alberto Marchesi 10577090*

*Marco Petri 10569751*

Professor: Matteo Giovanni Rossi

Academic year: 2020/2021

Contacts:

Davide Li Calsi [davide.li@mail.polimi.it](mailto:davide.li@mail.polimi.it)

Andrea Alberto Marchesi [andreaalberto.marchesi@mail.polimi.it](mailto:andreaalberto.marchesi@mail.polimi.it)

Marco Petri [marco.petri@mail.polimi.it](mailto:marco.petri@mail.polimi.it)

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# Introduction

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Virus SARS-Cov-2 has influenced the whole world during 2019 and 2020 and continues to influence it. Several governments across the world decided to take restriction measures to avoid the infection. The system to be should work in order to make store’s customers able to line up digitally to enter a grocery store, or to make a reservation for a given time on a given day. This part of the document explains the purpose of the project, the scope, definitions and acronyms used, document’s revision history, reference documents and the document structure.

## Purpose

The system is aimed to be used on the Italian territory for a grocery store’s chain by customers of the stores. The system’s purpose can be divided in two different categories:

* **Service for customers**: a service is offered to grocery stores’ clients and is realized with a digital system. The service must allow users to queue online in order to access the store until is their time of entering and to book visits to the store later than at the time of reservation;
* **Avoiding crowds**: avoiding crowds is the aim of the system which is intended to substitute the classical lining up methods (tickets and queues).

The system is intended to be easily usable and accessible almost to everyone who has access to an electronic device where external applications can be installed. The system can be used by the user to queue and to see how much wait time there is to achieve the possibility to enter the store. These two system’s characteristics are used to ensure the goal of having the minimum amount of people waiting outside the store to be able to enter on it.

The system should be able to trace customers visits and to save customers mean visit time and store it for future computations. Once the system has traced a certain number of visits of a customer, it would be able to estimate the visit duration time for it and use this estimation to compute the number of people able to access the market at that visit time. The system should trace every customer which visits the store and save the visits durations in order to be able to compute the mean time of a visit for that client.

The system should be possible to be used parallelly to a physical system of lining up at the store’s entrance for those people who cannot afford the application due to technology limitations. The system goal is to balance the digital queue with physical queue of people which cannot use the digital system.

Goal of the system can then be summarized as follows:

* Goal 1: user can wait its turn from home until is called;
* Goal 2: user can book a visit to the store;
* Goal 3: user can optionally insert the approximate duration of the visit;
* Goal 4: user can optionally insert items or the items’ category they intend to buy;
* Goal 5: system provides a precise estimation of waiting time to the user;
* Goal 6: system alerts the user about the time they need to reach the store;
* Goal 7: system suggests alternative time slots in case the one requested is full;
* Goal 8: system can suggest other stores to the user;
* Goal 9: system can give periodic notification of available time slots to the user;
* Goal 10: system output a QR to the user to identify its digital queue number and it is unique.

## Scope

The system is put on an environment composed of different entities which are part of the world: customers, store and security staff. System is used by different entities like customers, security staff and the store. With security staff we intend the people involved in the activity of controlling people’s numbers when a number is called and a person says it’s his number.

It follows the list of world (only) phenomena:

* User select a store to buy things;
* User opens the application;
* User goes to the store;
* User shows its number to security staff;
* User takes its shopping items;
* User pay.

It follows the list of shared phenomena:

* The store sets the maximum amount of people for a group;
* The store sets the maximum amount of people inside a certain sector;
* User enters in the (digital) queue;
* User checks the estimated waiting time;
* User books a visit;
* User inserts the items or items’ categories in to-buy list;
* User inserts the approximate duration of the visit;
* User receives an alert about the time needed to get to the store;
* User receives a list of alternative time slots;
* User receives a list of alternative stores;
* User receives a notification of a free slot;
* User shows the QR code representing their number to the security staff;
* User shows its QR code;
* Security staff controls a QR code shown by a user.

It follows the list of machine phenomena:

* System computes the number of a client;
* System calls a number;
* System verifies if a number is the number of the customer which should enter;
* System computes the estimated waiting time (for each customer);
* System computes mean duration of a visit for a long-term customer;
* System evaluates the distance between the customer and the store;
* System finds alternative time slots;
* System finds other near stores.

## Definitions, acronyms and abbreviations

Definitions:

* **Queue:** it is the queue that customers need to be in before entering a store(fifo)
* **Ticket:** it can be digital or paper based. It contains a unique QR code used for verification and a number indicating the position at the queue
* **Ticket machine:** a machine that provides tickets
* **Queue display:** a screen displaying the number of the ticket whose holder is to be admitted into the store
* **Checkpoint:** a point at which ticket and temperature checks are performed
* **Checkpoint controller:** a worker who performs checkpoint checks
* **Category:** a set of products with similar characteristics
* **Sector:** a store’s well defined area where products of certain category are stored

## Revision history



## Reference documents

1. http://dati.istat.it/Index.aspx?DataSetCode=DCCV\_ICT

## Document structure

# Overall description

2

Introductory text to the chapter (how it is subdivided and what are we going to say in the chapter)

## Product perspective

In this section are first presented scenarios to provide examples and more details on the shared phenomena defined in the previous section. Secondly is provided the domain model.

Scenarios:

* An elderly woman, who does not have internet access from home, is running out of food and needs to go shopping for groceries. Once she arrives at her favourite store, she retrieves a ticket from the ticket machine by pushing a button. She observes the queue display waiting for her number to appear, while making sure she stays at safe distance from other people. Once her number appears she proceeds at the checkpoint to be controlled. She passes the controls, finishes shopping, and heads home.
* A family of three composed by a father, a mother and a 4 years old child needs to buy supplies for the whole family. The father logs in the application from his phone, and starts booking a ticket for their favourite store. Since they will go all together, he specifies that the ticket is for a group of three people. He then selects the store, the date and the time as it is suggested by the application. Since they already know what to buy, he inserts the categories of the items to buy. When it’s time for them to head there, they receive a notification to remind them. They arrive to the store on time, and proceed at the checkpoint. The checkpoint controller performs the usual controls and lets them all in together since their ticket is for three people. They complete their purchases and head home.
* The manager of a small grocery shop wants to change the opening hours of his shop. He logs in his store’s account on his pc, and he sets the new hours from the console. He then realizes that since he has recently reorganized dairy section, more people can safely be in there. He therefore also increases the maximum number of people in that section. He saves the changes and keeps on with his day.
* A worker of a bakery is tasked to be the checkpoint controller of his store. He needs to make sure that the customers respect the queue. To do so, he scans the QR code on every customer’s ticket with his phone. A girl approaches and hands him her phone displaying the QR code. He scans it, his app confirms the code validity, and he lets the girl in. Then a woman approaches him with a paper ticket from the ticket machine. He scans it but this time the code is not valid, as that number is yet to be called. He tells the woman to wait for her number to be displayed on the queue display, and keeps on working.
* (registrazione)

Interfaces:

* **User Interfaces:**
  + **Customers web app:** offers all the ticket booking and related functionalities
  + **Store managers web app:** offers a console where the manager can set store’s parameters like opening hours or sections
  + **Checkpoint controllers web app:** accesses the user camera and scans the ticket’s QR code, showing on screen its validity
  + **Ticket machine UI:** very easy and basic UI with a button to print a ticket
* **Hardware interfaces:**
  + **Ticket machine:**
  + **Computers:**
  + **Mobile devices:**
  + **Queue display:** it display the queue number in very big font making it easy to read
* **Software interfaces:**
  + **Web app:** unique app for all users that offers different UIs and functionalities depending on the logged user type
  + **Ticket machine software:**
  + **database**

Diagram, engineering drawing, schematic

Description automatically generated

Figure 2.1

The application domain model is composed of different actors, the main actors are the customer, the QR code controller and the store. The first can visit a store multiple times both visiting it booking a visit either queuing online or physically. After the turn of the customer has been called it can enter the supermarket, however in order to be allowed to access it, it must show its QR code to the QR code controller. The QR code controller uses a QR Reader on a mobile device which gives it the information about the possibility of the customer to enter the supermarket. Every QR code is related to a visit of a customer to a supermarket and its code is unique and composed of a number and a date. Here we show a top-level class diagram of the application involving all actors which are recorded by the system.

The system is composed of different actors as we can see in the class diagram. The behaviour of the system and its actors is expressed using UML State Diagrams as formalism to represent machines’ states.Diagram

Description automatically generated

Figure 2.2

Customers can arrive to the supermarket with three reasons: taking a ticket, arriving because of a booking or arriving because its digital turn is going to be called or has called. In this diagram (figure 2.2) is described customer’s state diagram while arriving to the supermarket in order to enter it having a booking number or a queue number.

Diagram

Description automatically generated

Figure 2.3

Customers can queue online in order to avoid doing a physical line. The customer’s state diagram (figure 2.3) involved in the activity of taking a number in the digital queue is describe here above.

Diagram

Description automatically generated

Figure 2.4

Booking a visit (andrea, completare)

Diagram

Description automatically generated

Figure 2.5

Ticket machine (andrea, completare)

Diagram

Description automatically generated

Figure 2.6

Checkpoint controllers have the role of controlling every ticket of the customers which reach the supermarket and are intended to enter. Their state machine diagram (figure 2.6) says how they evolve while doing this specific activity. They control ticket until they have to do that.

Diagram

Description automatically generated

Figure 2.7

Manager (andrea, completare)

## Product functions

The system will provide useful functionalities to both customers and store managers/employees.

The main customer-oriented functions are **remote queuing** and **booking a visit.**

The first functionality consists in letting the customer join a digital queue for a given store by providing the customer (upon request via their device) a valid e-ticket. Such ticket is the union of a waiting number plus a QR code aimed at proving the validity of the ticket itself. In order to obtain their ticket, customers will have to select a store from a digital map that displays all available stores within their surroundings. Before the number associated with their ticket is called by the store, customers will also be able to see an estimate of their waiting time, dynamically calculated by the system and displayed on their device. The system will also notify customers when they should leave from home to get to the store: such notification will be planned by the system based on an estimation of the time that a customer might take to arrive at the store. In addition to that, the backend will be in charge of avoiding an excessive number of people in the store. In order to do so the system will not call a new number unless there is a free spot in the store.

The latter function permits a customer to plan and book a visit in advance, opposed to the remote queuing function whose role is the management of short-time queues. Customers who select this option will have to specify a store for their purchases among the ones displayed in the same map as before. Then the system will display a time-table with all the available and occupied time slots in the store, for the user to choose the most suitable one. The system will also send the user a list of alternative solutions, both possible pre-defined time slots or alternative stores for their purchases. Regardless of the option that they choose, the system will send customers a QR code that shall be shown upon entering the store. Customers also have the option functionality of providing a list of items that they intend to buy, for more accurate estimations.

On the other hand, the system will also provide some key **configuration functionalities** to store managers. They will in fact be able to set some core parameters in order to regulate fluxes and clusters of people within their store: e.g. they will decide how many people are permitted to stay within one group, how many customers are allowed to stay in a given store section, the duration of time slots and so on. Furthermore, one or more among the store employees will have access to a **QR scanning functionality**, in order to scan the QR codes of employees to monitor their access. Scanning a QR code will establish whether it is valid or not and will automatically make it non-reusable.

Finally, the system will provide general purpose functionalities to all of its users, such as **registering, login, account management …** Distinction will be made between regular customer accounts, employee accounts and store manager accounts. Each user will obviously have access to the functionalities of their role i.e. customer will only have access to customer-oriented functionalities.

## User characteristics

This section presents the users and their characteristics:

* **Store**
  + They are in charge of their store’s organization. In particular they decide the opening hours, and the maximum number of people for each ward.
* **Customers**
  + They can be of any demographics. Shopping for groceries is a need that everybody has.
  + Their ability to interact with technology varies greatly. While younger generations are accustomed to use technology the elderly might struggle to use complex applications.
  + Even though in developed countries the vast majority of customers is expected to have internet access at home, a sizable portion still doesn’t. According to a 2020 statistic, in Italy 76% of households has it.[1]
  + Normally customers go grocery shopping with a least a vague idea of the items to buy.
  + The time spent in the store by costumers varies greatly. It can usually be loosely predicted by the costumers.
* **Checkpoint controllers**
  + They are workers who control the flow of customers at the entrance of the store.

## Assumptions, dependencies and constraints

1. Customers are not allowed to enter unless they have received a ticket or they have booked a visit.
2. Customers can get their ticket by either using their app or physical machines at the store, and in no other way. Visits can be booked by using the app, and in no other way.
3. The maximum number of people allowed to be in a store sector at the same time N is known.
4. Customers who book a visit and declare in advance their intended actions will respect their declarations, i.e. they will not visit sectors other than the declared ones (this could be achieved by granting special discounts to those that do respect their declarations or by enforcing sanctions if a customer buys a product from another section) \*to move somewhere else.
5. Customers who book separate visits/ get different tickets will not get in direct contact inside the store, thanks to some employees in charge of controlling their behaviour.
6. Access to the store by ticket (i.e. for the queuing customers) is granted if and only if the customer's ticket number has been called and the next ticket number has not been called yet.
7. Customers who leave the store make their ticket or booking no longer usable, regardless of what they purchased, i.e. they need a new ticket or the booking of a new visit to enter again. \*requirement maybe
8. Customers enter one group at a time.
9. Each booking requires the specification of the number of people that will make the purchases withing the same group.
10. Customers who get a ticket through their app must show their QR code in order to prove the validity of the ticket, either on their phone or on paper.

# Specific requirements

3

Introductory text to the chapter (how it is subdivided and what are we going to say in the chapter)

## External interface requirements

### User interfaces

### Hardware interfaces

### Software interfaces

### Communications interfaces

## Functional requirements

**Registration**

* Connection
* Fill fields
* Validation

**Store manager sets parameters**

* Store managed logs in his system interface
* Store manager may set:
  + Maximum number of customers for each sector of the store
  + Sets the duration of time slots
  + Sets the maximum duration for a visit
  + Sets the opening hours

**User receives the notification of free slots**

* System sends a notification to the user periodically of a free slot

**Take a ticket via internet**

* Select store
* Ask ticket
* Show waiting time

Notification to arrive

* Send notification to arrive to the shop

**Take a ticket personally**

* Go to the machine
* Take the ticket

**QR code validation**

* User get closer to QR controller
* Show code
* Use case: QR code controls validity

QR code controls validity

* QR code controller scan QR with its machine
* QR code controller verifies the validity

**Book a visit**

* User chooses the preferred store
* Use case: Selection of the time slot
* Use case: Selection of duration for a visit
* Use case: Selection of items for a visit

Selection of the time slot

* User chooses the visit day
  + If that day is full, other stores are suggested
* User receives a list of available time slots
* User receives a list of suggested time slots
* User selects a time slot or ask for a suggestion

Selection of duration for a visit

* If the user is a long term user may specify duration, instead it must

Selection of items for a visit

* User can select exact items if present, if not it selects the category

**Requirements and comments**

Intelligent granularity: no category of things with milk, pasta category ok

requirement: chosen time slots must be consecutive

requirement: suggested time slots are distant from each other of K minutes

## Performance requirements

## Design constraints

### Standard compliance

### Hardware limitations

### Any other constraint

## Software system attributes

### Reliability

### Availability

### Security

### Maintainability

### Portability

# Formal analysis using alloy

4

Introductory text to the chapter (how it is subdivided and what are we going to say in the chapter)

# Effort spent

5

This part is the part which summarize the effort spent by each member of the team in the documentation building process.

|  |  |
| --- | --- |
| **Davide Li Calsi** | |
| Introduction | 2hrs |
| Overall description | 3hrs |
| Requirements | 0hrs |
| Alloy | 0hrs |

|  |  |
| --- | --- |
| **Andrea Alberto Marchesi** | |
| Introduction | 1hrs |
| Overall description | 6hrs |
| Requirements | 0hrs |
| Alloy | 0hrs |

|  |  |
| --- | --- |
| **Marco Petri** | |
| Introduction | 2.5hrs |
| Overall description | 2.5hrs |
| Requirements | 0hrs |
| Alloy | 0hrs |

# References

6

Introductory text to the chapter (how it is subdivided and what are we going to say in the chapter)